The Snub Cube in the Glanville Courtyard of the Beckman Institute

at the California Institute of Technology

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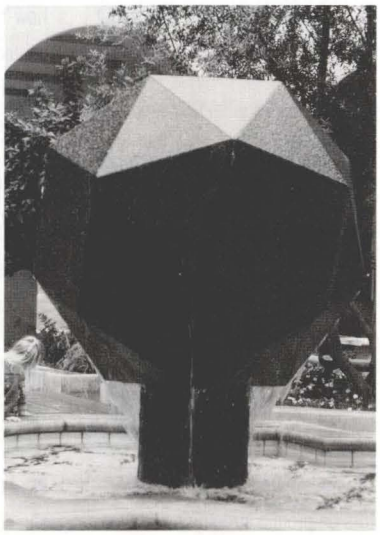
In the central (Glanville) courtyard of the recently constructed Beckman Institute building at the California Institute of Technology is a fountain, placed there by the architect, Mr. Tim Vreeland, to create some "white noise" and thus separate acoustically four areas of the courtyard designed for conversational groups. The architect asked for help from the future occupants of the building in designing the fountain itself; several suggestions were made and rejected by the Caltech administration as not having any relationship to the purpose of the building. Arnold O. Beckman, the donor of the building, had specified that he wanted this Institute to develop new methods and instruments that would advance research in the fields of biology and chemistry, including their interface. After our latest suggestion had been rejected, Harry B. Gray, then the Director-designate of the Beckman Institute (now Director), recalled a paper [1] describing the tertiary structure of the iron-containing protein ferritin; the molecule of ferritin was found to have 432 (read as four, three, two) symmetry; i.e., it has fourfold axes, threefold axes, and twofold axes relating the 24 subunits of the protein.



Three views of the snub cube sculpture (1996) pages 48–50. Close-up. (Photo by I. Hargittai)

Now, the ferritin protein seemed to Harry Gray to be an excellent symbol for the work that would be done in the new building. Ferritin is found in plants and animals alike; it is an iron-storage protein containing up to 4500 iron atoms in a hydroxyphosphate complex form in the core, surrounded by the organic protein shell. Thus, the molecule can be claimed by biology, organic chemistry, and inorganic chemistry, all three fields that were to be emphasized in the Beckman Institute. Harry asked me to design something for the courtyard fountain that would capture the essence of the ferritin structure.

The essence of any structure is its symmetry [2]; this was the obvious starting point for the design. And because I am a crystallographer, symmetry was a handy tool for me to use. I looked in the *International Tables for X-Ray Crystallography* [3] and found the simplest space group that had 432 symmetry; that turns out to be space group #207, a cubic space group with symmetry *P*432 and 24 general equivalent positions, just the same as the number of subunits in the ferritin molecule. In order to visualize this structure, I used the computer program ORTEP, written by Carroll Johnson [4], and placed an arbitrary atom in the unit cell. The program used the 432 symmetry of the space group to generate the other 23 equivalent atoms and then drew a picture of the result. I discovered that by joining the "atoms" I had generated by "bonds," I had the outline of a solid; I could vary the shape of the solid by changing the position of the arbitrary "atom" I started with. The solid had 6 square faces and 32 triangular ones, with 24 corners. The corners, then, would represent conceptually the subunits of the ferritin molecule. Some of the triangular

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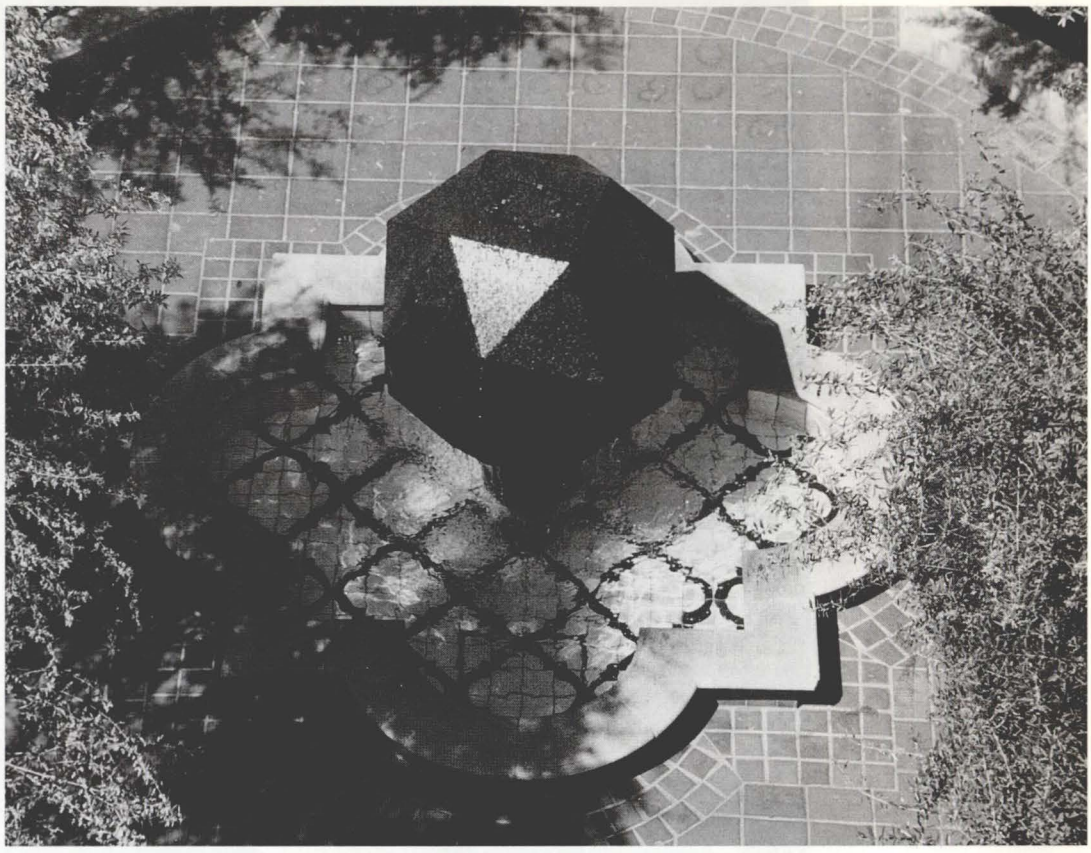
With its pool and its tiling.
(Photo by William P. Schaefer)



faces could be either acute or obtuse, and I made paper models of both kinds to see which was more pleasing to the eye. I favored the solid with somewhat acute triangular faces, but my colleague Verner Schomaker pointed out that the solid with all equilateral triangles was special: it is called the snub cube, and Verner said that it was one of Linus Pauling's favorite solids. (The other was the icosahedron.) It is in fact an Archimedean semiregular solid, derived from a cube and having only two kinds of faces, squares and equilateral triangles, with all its edges of equal length.

(There are two other facts about the snub cube that may be of interest. First, despite its apparently high symmetry, with all sorts of rotational axes running through it, it has no planes of reflection; it exists in two forms, one left-handed and the other right-handed. Second, as with any semiregular solid, the snub cube can be inscribed in a sphere. In this case, the 24 points on the sphere represent the distribution for which the smallest distance between any two is as great as possible [5].)

The model I made of the snub cube pleased the architect as well as the Administration, and we decided to use a snub cube as the decorative element in the fountain of the Beckman Institute. The contractor who was to build this, though, insisted on making a half-sized model first to see if water could be made to flow evenly over the surface of such a solid. He was used to building much more symmetric fountains and was skeptical about this. A wooden model, though, showed that with a sufficiently strong flow, the entire surface of the solid could be wet; we were given the go-ahead to install a five-foot-tall, granite snub cube in the fountain. The granite chosen was a green variety from Africa. It was quarried there and shipped to Italy for cutting into slabs, and the slabs were shipped to California. The subcontractor charged with fabricating the actual fountain claimed not to be able to build such a complicated form, so I used the ORTEP program again to calculate all of the inter-facial angles that he needed to know, and I gave him precise measurements to work from. With these measurements and angles, the man went ahead with fabrication, first flaming the outer surface of the granite to roughen it and produce something that

Jay A. Labinger, William P. Schaefer, and Verner Schomaker on February 19, 1996.
(Photo by I. Hargittai)

With the Beckman Institute in the background. (Photo by William P. Schaefer)

would be as hydrophilic as possible, and then attaching the cut slabs of granite to a stainless-steel armature he had built to my specifications. The plumbers would later run a pipe up through the snub cube to discharge water over the top, so it would flow down the sides and into the pond at the bottom, to create the white noise the architect wanted. The final granite construction is five feet across, from square face to square face, and, because of its cubic symmetry, also five feet tall. It rests on a cylindrical pedestal of green granite about 18 inches high, so the top of the snub cube is visible only to quite tall people, or from the upper floors of the building.

The fountain, with its impressive granite snub cube, has been functioning for nearly six years. The Beckman Institute building won an award given by Pasadena Beautiful for the most beautiful noncommercial building built in 1991, and the snub cube fountain itself was recognized by the City of Pasadena in 1992 as one of the ten best examples of public art in the city. The citation recognized as "artists" of the sculpture Harry B. Gray and William P. Schaefer, the first time either of us had won such a distinction. We continue to be pleased with our work.

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